Photo Credit: GIZ/ ESDS Ethiopia

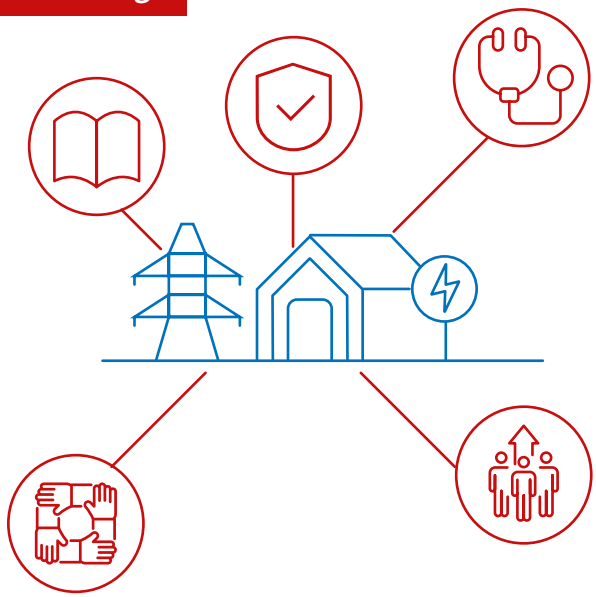
POWERING PROGRESS: PILOTING INCLUSIVE AND AFFORDABLE ELECTRICITY ACCESS SOLUTIONS IN DISPLACEMENT SETTINGS

About SUN-ESDS

Energy Solutions for Displacement Settings (SUN-SUN-ESDS) is a component of the Global Programme with UNHCR (SUN), which is commissioned by the German Federal Ministry for Economic Cooperation and Development (BMZ) and implemented by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ). The Global Programme supports UNHCR in facilitating the operationalisation of the Global Compact on Refugees (GCR) in the Humanitarian-Development-Peace (HDP) Nexus. Its core mission is to address pressing energy challenges faced by populations affected by displacement. By focusing on the integration and deployment of reliable, clean, and sustainable energy solutions, SUN-ESDS aims to enhance the quality of life, well-being, and environmental conditions of affected communities. The project is instrumental in supporting the wider humanitarian, development and peace community in meeting the objectives of the Global Compact on Refugees (GCR).

Importance of Electricity Access in Displacement Settings

Reliable electricity is crucial for improving quality of life, economic opportunities, and essential services in displacement settings. It powers key infrastructure like schools, health centres, and administrative offices, ensuring vital services such as lighting, communication, and refrigeration. This enhances **safety, education, health, and socio-economic growth, fostering community resilience and social cohesion.** Aligned with SDG 7.1 and the Global Compact on Refugees, electricity access improves living conditions, reduces reliance on fossil fuels, and supports environmental sustainability through solar solutions. Electricity access interventions are at the core of the SUN-ESDS project's mission, addressing immediate needs while laying the foundation for long-term, climate-resilient development for refugees and host communities.



UNHCR's **Global Sustainable Energy Strategy (2019–2025)** highlights electricity access as vital for protection, resilience, and dignity in displaced communities. It promotes partnerships and innovative financing models like pay-as-you-go, blended finance, and micro-finance to expand access. Key to this approach is fostering public-private partnerships (PPPs) that ensure affordable, reliable electricity for refugees and host communities.

german cooperation
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Implemented by:
giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

In cooperation with:
UNHCR The UN Refugee Agency

Description of the Intervention

The SUN-ESDS project employs a comprehensive, multifaceted approach to electricity access across **Ethiopia, Kenya,** and **Uganda,** targeting both the provision of sustainable energy solutions for refugees and host communities and the electrification of critical social infrastructure like schools and health facilities. This dual strategy, seeks to enhance the quality of life, foster economic opportunities, and support job creation in displacement settings.

To achieve these goals, SUN-ESDS has strategically invested in infrastructure while collaborating with private sector actors to develop electricity access solutions and extend last-mile market reach. Incentive mechanisms such as results-based financing (RBF) and subsidies have been employed to lower financial risks and attract private investment in scalable, innovative energy solutions.

For example, in **Kenya's Kalobeyei settlement, hybrid mini grids** aim to deliver affordable and reliable high-tier electricity for homes and businesses, underscoring the project's focus on sustainability and inclusivity. Similarly, mini-grid initiatives have targeted underserved off-grid areas of northern Uganda.

Solar-powered Energy kiosks and hubs represent a cornerstone of SUN-ESDS's strategy to address energy access challenges. In **Uganda, energy kiosks** serve as pivotal platforms for facilitating private sector engagement in delivering last-mile electricity solutions, enabling more inclusive and accessible energy services for underserved populations. Meanwhile, **Ethiopia's Gambella region hosts a multi-purpose energy kiosk** that not only improves access to energy but also integrates recreational and entrepreneurial services, fostering innovation and community engagement. These new infrastructures aim to address gaps in energy markets, enhance local economic activities, and bolster community resilience, contributing to sustainable development in displacement settings.

Significant solar system upgrades and investments have been implemented in selected **health centres in Ethiopia and Uganda** to enhance the quality of services provided. Though not originally part of the SUN-ESDS core activities, these interventions were introduced as part of the **Covid-19 response** and aim to strengthen essential infrastructure, ensuring reliable energy access that supports improved educational outcomes, better healthcare delivery, and overall service efficiency. By addressing these critical needs, SUN-ESDS aims to contribute to a substantial improvement in the quality of life for people in displacement settings, fostering greater resilience and long-term development opportunities for refugees and host communities alike.

In **Uganda**, SUN-ESDS piloted new incentives to attract energy service providers into the delivery of solar home system and lighting solutions for refugee and host community households. This was achieved through the design and implementation of an innovative, **supply-sided results-based financing (RBF) scheme** which aimed to incentivise producers and distributors to retail quality solar systems in refugee settlements and host communities. This approach strengthens the renewable energy value chain and supports the establishment of markets, services, and infrastructure in displacement settings.

To ensure sustainability, SUN-ESDS has considered **operation and maintenance (O&M)** by supporting the capacity-building of both public and private-sector actors. These include specialised training and the piloting of innovative O&M financing models, reinforcing the focus on enhancing the durability and effectiveness of new electricity infrastructure investments in displacement settings.

By piloting market-based approaches and fostering **public-private-community partnerships,** the project lays the groundwork for scalable, socially impactful electricity access solutions. Its initiatives reflect a strong commitment to innovative, inclusive, and affordable energy strategies that prioritise community needs and long-term sustainability.

Locations:	Ethiopia, Gambella Region Uganda (multiple locations) Kenya, Kalobeyei (several locations)
Target group:	Refugees and host communities, Private Sector and NGOs
Timeframe:	2019 – 2024

Methodology of the Intervention

HH with SHS, Siripi Zone, Rhino Camp Refugee Settlement, Mr. and Mrs. Benyi. Photo Credit: Sandra Haskamp

RBF Scheme for Solar Home Systems and Lanterns in Uganda:

In October 2020, SUN-ESDS partnered with **Energising Development,** an international flagship programme for providing energy access, to launch a call for organisations interested in participating in a new pilot RBF scheme. This initiative aimed to stimulate market entry and sales of Tier 1 and 2 solar home systems (SHS) as well as pico PV solar lanterns and charging lanterns that met rigorous performance and quality criteria. Standards were aligned with benchmarks from Lighting Global, **Verasol** and Uganda National Bureau of Standards, focusing on key attributes such as energy performance, lighting brightness, affordability, ease-of-use, durability, safety and warranty coverage.

The initial RBF call was met with minimal interest from companies and repeated outreach was required to understand reservations and obstacles faced by companies toward displacement settings. This outreach later resulted in the selection of two companies that were incentivized to promote product sales in several refugee settlements and host communities in Uganda – locations often considered high-risk or commercially unattractive. The scheme was designed as a hybrid supply-sided RBF model combining performance-based incentive payouts tied to product sales and up-front financing (approximately 20-25% of costs) to reduce financial risk and cover

initial operational expenses which were necessary to either scale-up their existing distribution systems or establish regional hubs, especially in Arua. To ensure market integrity, products were sold at full market price, and a third-party verification process was implemented post-sale to confirm compliance with sales targets and eligibility criteria.

During the first RBF window (2020-2022), suppliers were tasked with achieving eligible sales of up to ~1,000 solar products, evenly distributed between refugee and host communities. Post-sales verification revealed that an average of ca. 12% of reported sales were ineligible. For the second window (2022-2024), a total eligible sales target of 2,113 solar products, maintaining the same 50-50 distribution between refugees and host communities was pursued. This expansion was due to the higher consumer preference for SHS rather than solar lanterns.

Based on lessons from the first window, SUN-ESDS revised the hybrid RBF model to increase incentives for eligible sales to refugee customers and to pilot a demand side subsidy (DSS) in selected zones. This helped suppliers to **improve their cashflow** and enable **stronger focus on reaching refugee customers**. In the second window, four companies participated, one of which had also been involved in the first window. This continuity highlighted an increased focus on social impact and leveraging prior experience to enhance the effectiveness of the hybrid-RBF scheme.

RBF model helped suppliers to

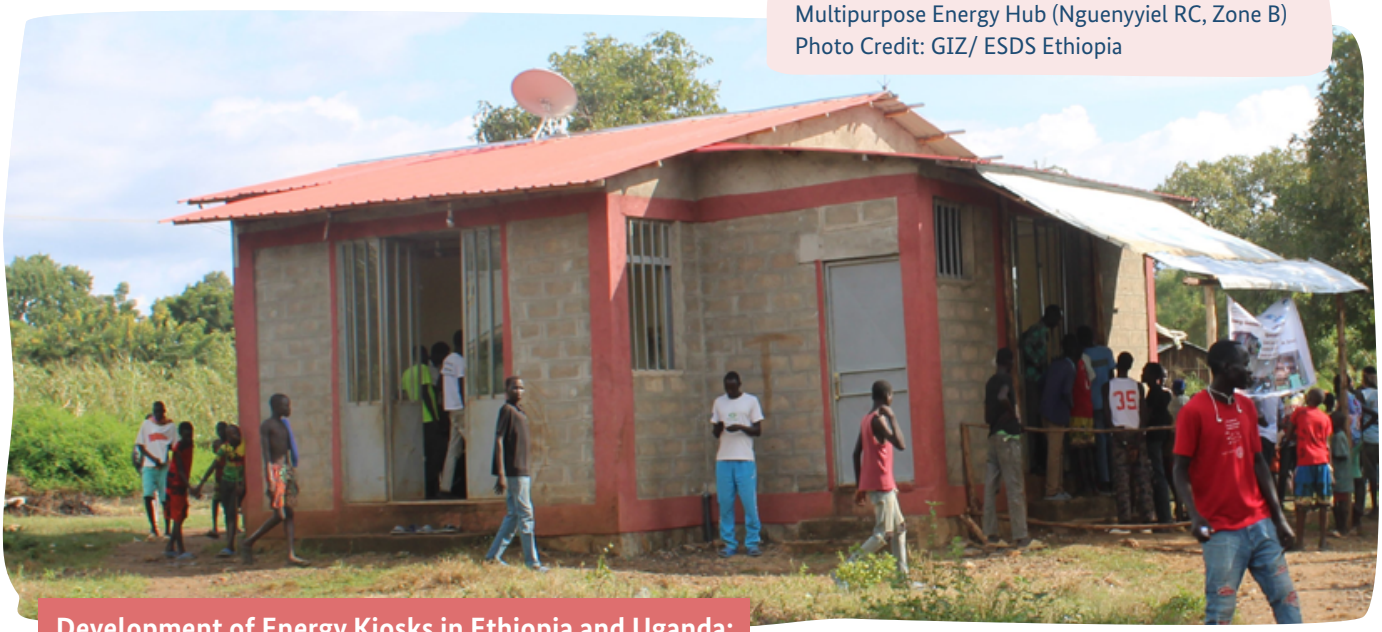
improve cashflow

reach refugee customers

Mrs. Betty, happy client of ICS and SHS:

“ Since we have light I don’t feel like a refugee anymore.”

Photo Credit: Sandra Haskamp



Multipurpose Energy Hub (Nguenyyiel RC, Zone B)
Photo Credit: GIZ/ ESDS Ethiopia

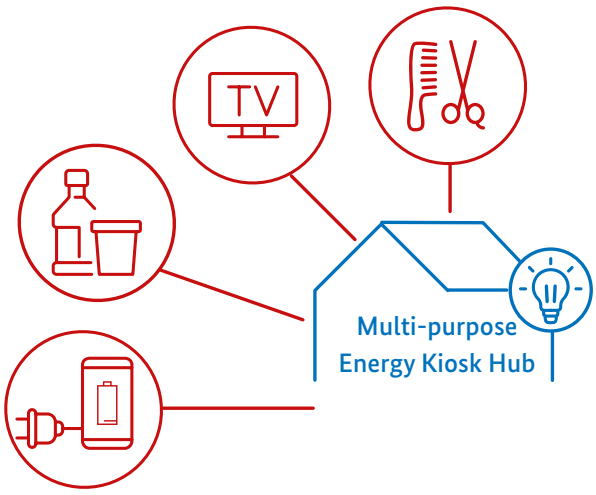
Development of Energy Kiosks in Ethiopia and Uganda:

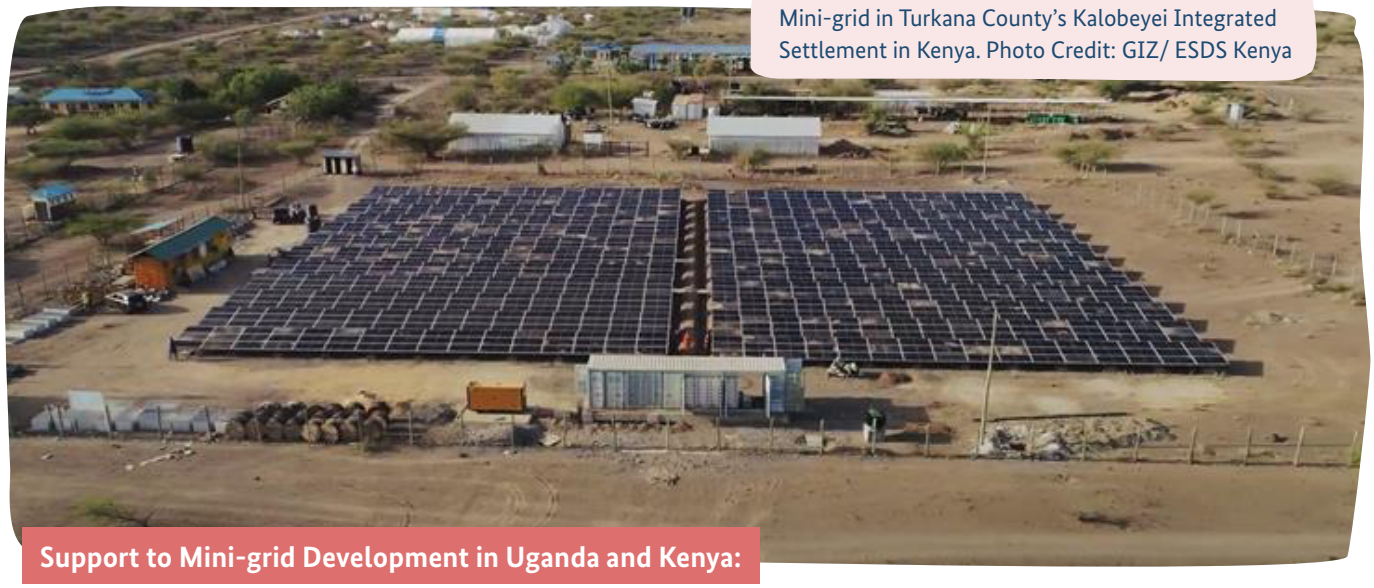
In 2019, SUN-ESDS began identifying sites for pilot energy kiosks in Uganda, and in 2021 and 2022, two energy kiosks were launched in **Rhino Camp Refugee Settlement** and **Bidibidi Refugee Settlement** respectively, serving as community hubs for energy access. The individual products and services of kiosks varied from improved cookstoves (ICS), pico PV products, solar home systems (SHS), or a combination thereof, as well as essential services such as phone charging, secretarial assistance, computer services, and cold drink sales. Designed to operate for 10–12 hours daily, the solar-powered kiosks were built to handle a minimum load of 3.8 kWh per day, enhancing local energy access.

The selection process for kiosk operators focused on established local businesses and community-based groups with approximately 10 members each. Eligible operators were required to have a physical place of doing business, proof of local tax payments, and formal terms of association or by-laws, fostering accountability and community engagement. To ensure their success, kiosk operators underwent management training and received start-up inventory from SUN-ESDS.

Energy kiosk activities in Ethiopia began in 2021 with the implementation of an Energy Kiosk Baseline Assessment and formation of a multi-agency task force. This was followed by a feasibility study to evaluate operational models, assess capacities, and identify suitable sites. The study informed the creation of a tailored business model, financial plan, and an operator selection manual. By 2022, construction of a pilot energy kiosk in the **Nguenyyiel Refugee Camp,** designed to serve over 40,000 customers, was underway. Operators received specialised training on business management, technical maintenance and customer service to ensure effective kiosk management, reinforcing emphasis on the sustainability of the initiative.

The Ethiopian energy kiosk is equipped with a 3kWp solar PV system, designed to provide reliable and sustainable energy solutions for the local community. Unlike the energy kiosks in Uganda, it operates under an innovative business model that sets it apart as a **Multi-purpose Energy Kiosk Hub**. The hub is leased to **four refugee operators,** who are responsible for its day-to-day management.





Mini-grid in Turkana County's Kalobeyei Integrated Settlement in Kenya. Photo Credit: GIZ/ ESDS Kenya

Support to Mini-grid Development in Uganda and Kenya:

In collaboration with the GIZ Uganda Pro Mini-Grids Project and the Ministry of Energy and Mineral Development (MEMD), GIZ played a pioneering role in advancing solar-powered mini-grid development across 28 villages in Lamwo District, Uganda. As part of this effort, SUN-ESDS and GET.transform provided financial contributions to install two mini-grids in Palabek Refugee Settlement and one mini-grid in a host community.

The groundwork for the Palabek Refugee Settlement mini-grids began in 2021, with the identification and formal allocation of land for two solar PV mini-grids in partnership with MEMD and the Office of the Prime Minister. To ensure the effective use of these mini-grids for economic empowerment, 417 refugee and host community members participated in a business idea competition designed to support productive use of energy (PUE) adoption through tailored business training, coaching, and financial assistance. Despite these preparations, progress was delayed, and it was not until 2024 that the selected private developer secured their financial contribution, enabling the manufacturing and installation of the mini-grid components. In November 2024, MEMD commenced the setup of the electricity distribution network, marking a significant milestone in the project. Throughout the delays, SUN-ESDS partner **Associazione Volontari per il Servizio Internazionale (AVSI)** played a crucial role in sustaining momentum by engaging local businesses in PUE investments to maximise benefits once the mini-grids become operational.

Mini-grid activities in Kenya have focused on expanding electricity access across several villages. In **Turkana County's Kalobeyei Integrated Settlement,** an existing mini-grid - initially developed with funding from the United Kingdom's Foreign, Commonwealth and Development Office (FCDO) in collaboration with En-Dev - was expanded under the SUN-ESDS initiative. By 2023, this effort aimed to extend reliable electricity to **Villages 1, 2, and 3**, as well as the **Kalobeyei Host Town,** to connect ca. 2,500 users, including households, businesses, and social institutions. This expansion was informed by a comprehensive technical and financial feasibility study conducted in 2022, which assessed the viability of hybrid solar PV mini-grids. The study also evaluated socio-political dynamics in the region to ensure smooth implementation in an area prone to conflict.

The extension was deemed essential to address previously underestimated demand, which had strained an existing 60 kWp system, rendering it unreliable. To resolve this, other existing mini-grid infrastructure was expanded using a blended finance mechanism. SUN-ESDS covered 80% of the extension costs for a 45 km medium and low-voltage distribution network, with the developer-operator funding the remaining 20%. To further meet growing energy demands, additional funding from Kakuma Kalobeyei Challenge Fund (KKCF) supported an upgrade of the system's capacity to 541 kWp, ensuring long-term, scalable energy solutions for the community. Technical trainings were provided for both employed and local technicians to support local capacity development for mini-grid O&M.

Siripi Health Centre III in Uganda.
Photo Credit: Sandra Haskamp

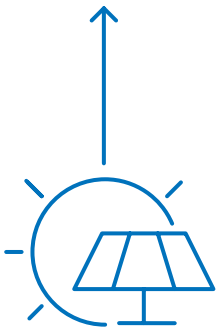
Solarisation of Health Centres in Ethiopia and Uganda:

As part of Covid-19 response efforts, baseline assessments were undertaken on the status of electrification and its impact on health care delivery, jointly commissioned by SUN-ESDS and EnDev in Uganda. This assessment supported the further planning for the electrification of health centres within refugee settlements and following site selection and tendering processes, SUN-ESDS deployed contractors to undertake technical activities to inform the sizing requirements for solar PV systems. By May 2021, three health centres in **Imvepi and Rhino Camp Settlements (ca. 3-7kWp capacity)** were solarized in Uganda through SUN-ESDS. This was supported by a further study approximately ten months later to assess the outcomes of the solarization activities. Similar activities were also undertaken in Ethiopia, which led to the electrification of five health centres in five refugee settlements in the **Gambella region (ca. 5kWp capacity)**. The electrification focused on critical areas such as laboratories, operating rooms, maternity wards and clinics, to ensure they could power lights, computers, communication systems, vaccine refrigeration and life-saving medical devices.

Siripi Health Centre III, Lab & Microscope powered by a stand-alone solar PV System.
Photo Credit: Sandra Haskamp

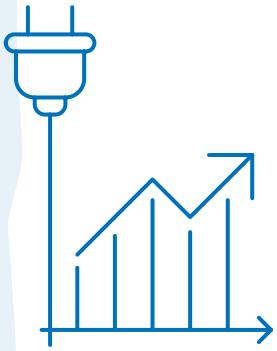
Achievements and Initial Impacts

SUN-ESDS's electricity access interventions have fostered the development and adoption of products, productive use of energy and improved facilities that meet the needs of host and refugee communities. These efforts are closely aligned with the GCR objectives and UNHCR's Energy Strategy, which prioritises enabling access to sufficient, safe and sustainable, energy to refugees and host communities. Early impacts indicate strong potential for scaling up market-based approaches in displacement settings, while paving the way for local economic development.



Boosting Solar Product Adoption Through Enhanced RBF Incentives:
In Uganda, a total of 3,388 solar products were sold to refugee and host community households via five solar RBF recipients engaged through the two RBF windows. Tier 1 SHS systems which typically consist of a 10W solar panel, 15-20Wh battery and 2-3 LED lightbulbs achieved the highest proportion of sales (ca. 85%) compared to other incentivized products in both windows. This is because they provide more utility to households, are affordable, and more accessible when combined with pay-as-you-go (PAYGO) repayment plans. Some companies offered PAYGO plans with an initial deposit of 38,000 UGX (ca. 10 USD) which is the maximum deposit fee consumers can manage. The Tier 1 SHS also performed better under the adapted hybrid RBF model featuring the DSS component compared to the initial approach. The adapted hybrid RBF's success demonstrates the viability of market-based solutions in displacement settings.

Bridging Electricity Access and Local Development:
Four energy kiosks are currently operational in Uganda's Bidibidi and Rhino Camp Refugee Settlements – each designed to serve ca. 3,500 households. The majority continue to serve quality energy products and services, and several have expanded their services, offering a diversity of opportunities for local populations, such as computer trainings, as well as conveniences of phone charging, banking services, phone repairs and chilled drinks. The sale of solar lighting products, has enabled the penetration of quality products to the last mile, improving the quality of life for local refugee and host communities. These achievements are linked to new efforts to link local energy kiosks with private sector solar suppliers, including those engaged through the RBF scheme implemented by SUN-ESDS in Uganda.

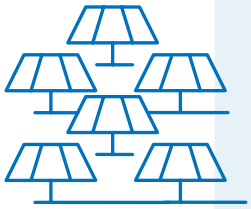


The **Multi-purpose Energy Kiosk Hub** in Ethiopia plays a crucial role in fostering economic empowerment and enhancing the quality of life in displacement settings. It offers refugee entrepreneurs income-generating opportunities while providing affordable energy-related services. Managed by four operators, the hub hosts diverse facilities, including a phone charging shop, café, cinema, and hair salon, serving as a central hub for both recreational activities, essential services, and community development.

A recent household survey revealed that local refugees pay 50% less for mobile phone charging at the hub compared to other providers, making essential services significantly more accessible and affordable. This is particularly impactful in the Gambella region of Ethiopia, where mobile phones are widely used as a source of lighting. By reducing the cost of mobile phone charging, the hub directly contributes to improved living conditions for its customers while supporting sustainable energy practices and community resilience.

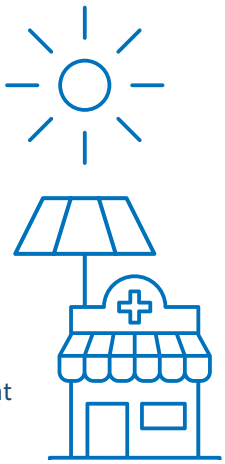
Soaring Mini-grid Connections in Kenya: The SUN-ESDS mini-grid extension activities and RBF scheme have led to a remarkable surge in electricity connections. A significant outcome was the developer-operator's ability to increase the Kalobeyei Settlement's system capacity from 60 kWp to 541 kWp. The original 60 kWp system was relocated to Kalobeyei host town, where it built on an existing 20 kWp system, expanding to a total of 80 kWp. While SUN-ESDS specifically financed the extension, its impact in the Kalobeyei Integrated Settlement has been transformative, enabling the mini-grid operator to achieve 3,000 new mini-grid connections. This includes an electrification rate of 31% among households in the settlement and host community, along with 275 businesses and 20 social institutions. Consumer satisfaction is notably high, particularly regarding electricity availability and reliability.

A recent interview with the current operator revealed that no more major outages have been experienced in the area since the commissioning of the new system and extension in October 2022. The reliable electricity supply has had profound socio-economic effects. Over 250 people have been directly employed through the activities, and nearly half of the connected businesses report extending their operating hours by an average of four hours daily. This has enabled them to more than double their monthly revenues, contributing to substantial economic growth. The availability of refrigeration has emerged as a significant driver of energy demand, both at the household and business levels. Additionally, the extended low- and medium-voltage lines have supported small-scale food processing, enhancing food preservation, availability, and nutrition within the region. These developments highlight the ripple effects of reliable and affordable electricity access on livelihoods and local economies.



Electrification of 11 health centres:
SUN-ESDS has successfully solarized five health centres in Ethiopia, three in Uganda, and connected three clinics in Kenya's Kalobeyei Settlement to mini-grids. These efforts have reduced reliance on diesel generators previously used for power during peak hours. The added solar capacity has boosted operational capabilities, extended service hours and improved the use of essential medical equipment, enabling staff to handle emergencies more efficiently, especially at night. These improvements have led to improved operational management, improved working conditions and higher staff retention.

Notably, Ugandan health centres have expanded their services by offering 6-10 additional services on average, including diagnostic tests, paediatric wards, mental health support, and blood transfusions, made possible by refrigeration via reliable power supply. In Kenya, the mini-grid connections have facilitated the introduction of new equipment like X-ray machines, have reduced waiting times and created jobs, further improving healthcare efficiency. These developments have led to increasing satisfaction of and trust in local healthcare services among communities served – as recently established through household surveys.



Each health centre serves a growing catchment of between 21,000 - 220,000 people, and patient numbers have been growing through referrals due to new services. In some cases, maternity and laboratory patient loads have more than doubled. The growing spectrum of services and people served appears to be pushing the reclassification of some health centres by authorities in Uganda (from level II-III and potentially from III-IV). This shift is likely to improve central resource allocation (personnel, financial) for the health centres, and further broaden accessibility for a range of new services for both refugees and host communities in the West Nile region.

Best Practices and Sustainability Aspects

The electricity access interventions by SUN-ESDS in Ethiopia, Kenya, and Uganda have highlighted the value of collaborative, inclusive energy solutions in displacement settings. By combining technical and financial support, SUN-ESDS has improved access for both refugees and host communities. Progress in piloting market-based solutions with private sector partners has also fostered local job creation, demonstrating SUN-ESDS's commitment to people-centred, market-driven solutions.

Adaptive Management to Drive Sales via RBFs:
A notable best practice emerged from one company's proactive decision to revise internal policies, enabling the provision of PAYGO services directly to refugee customers; this entailed a shift away from working with third party distributors. This approach not only expanded access but also positioned the company as the most performing supplier in terms of eligible SHS sales. Many sales were supported through concerted marketing efforts of SUN-ESDS.

In addition, SUN-ESDS demonstrated best practice in agile and adaptive management by successfully transitioning to a customized hybrid-RBF model during the second window. This success was underpinned by the strategic provision of upfront payments to companies and higher incentives for eligible sales to refugee customers, enabling suppliers to invest in critical distribution resources, particularly personnel - key to ensuring last-mile accessibility for products and services. All participating solar companies engaged in Uganda provided comprehensive customer support, including user instructions and a two-year warranty on the full range of products offered through the RBF scheme. During the warranty period, customers benefit from robust after-sales services, including technical troubleshooting by dedicated technicians, coverage of repair and spare part costs, and complete product replacement in cases of product faults.

HH with SHS on a street in Bidibidi Refugee Settlement in Uganda. Photo Credit: Sandra Haskamp

Siripi Energy Kiosk selling different RBF products. Photo Credit: Sandra Haskamp

Recognition of Quality Energy Products at the "Green house" in Uganda

The recently established energy kiosks in Uganda, locally known as "the green house," have become trusted hubs for essential energy services and products. Their highly visible and strategically located structures have made them a focal point within the community, attracting a growing number of households in search of dependable energy solutions. A recent household survey highlighted high levels of customer satisfaction, with reliability and product quality emerging as key factors behind the kiosks' strong reputation. Indeed, they play a critical role in improving access to certified and affordable energy products in last-mile communities. By bridging the gap between local energy needs and product availability, they have become integral to enhancing energy access. The kiosks' ability to combine accessibility, affordability, and product quality has solidified the position of the "green houses" as indispensable resources for both refugee and host communities. They demonstrate the transformative potential of energy access initiatives, empowering households, fostering trust, and contributing to the broader adoption of sustainable energy solutions in underserved areas.

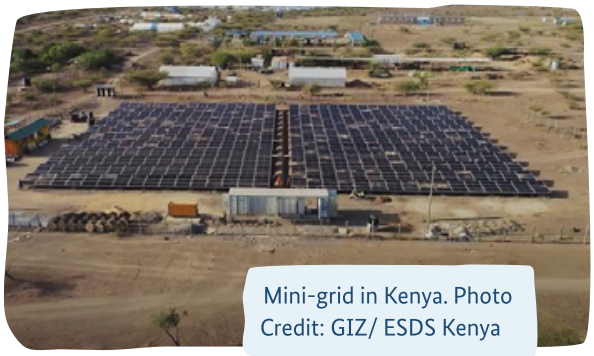
Integrated Energy Hubs Transforming Refugee Communities:

The strong demand for phone charging and repair services in Ethiopia underscores the energy hub's viability and critical role in the community. By addressing essential needs and supporting small businesses, the hub showcases how expanding energy access can drive local economic activity and significantly lower service costs, such as phone charging, benefiting cash-constrained households. This affordability is vital for advancing socio-economic empowerment in vulnerable communities. Moreover, the hub's integration of daily convenience and recreational services, managed by multiple operators, creates a dynamic space that fosters entrepreneurship, strengthens community cohesion, and enhances resilience. By serving as a central hub for both economic and social activities, it contributes to improved well-being and a more sustainable quality of life for those living in displacement settings.

Charging Services at Multipurpose Energy Hub in Nguenyyiel Refugee Camp. Photo Credit: Egzieryalew Ayele

Innovative Financing Driving Reliable Electricity Supply and Customer Growth: The blended finance model between the solar-hybrid mini-grid developer, SUN-ESDS, and the KKCF has been pivotal in expanding the mini-grid system to accommodate a larger customer base. This collaboration reduced business risks and significantly boosted connection rates. With financial support for system expansion and technical assistance for battery upgrades, the developer-operator proactively lowered connection fees from KSH 1,000 to KSH 500 for all new customers, regardless of category. This adjustment led to a sharp rise in new connections, particularly among businesses and households, before eventually stabilizing.

The stabilization of connection rates reflects the system reaching its current coverage capacity rather than a decline in consumer demand. The mini-grid presently operates at a tariff of 35 KSH (ca. 0.27 USD Cents) per kWh, with average monthly consumption around 54 kWh per user. Recognising the continued



Mini-grid in Kenya. Photo Credit: GIZ/ ESDS Kenya

demand, the developer plans to expand the system further, which is expected to drive additional connections, particularly among households. In addition, the current tariff, which is based on the principle of cost-recovery ensures financial sustainability for system repairs and upgrades. Day-to-day O&M is undertaken by local technicians in Kalobeyei settlement who were further trained by SUN-ESDS. The mini-grid is remotely monitored and for more complex issues, the operator deploys specialist technicians. This approach underscores the role of innovative financing and technical support in fostering sustainable and affordable energy access, and economic growth.

Innovative O&M Financing Model Tested in Uganda: To explore alternative financing options for O&M, SUN-ESDS piloted the "canteen" model at Ofua and Imvepi Health Centre in Uganda, building on earlier studies conducted. With permission from the local government, this service-oriented approach seeks to generate income within public institutions, like health centres, to cover O&M costs for energy systems, addressing the challenge of insufficient public budgets for system maintenance. The model uses the presence of a "canteen" or small shop in health centres to support energy system upkeep once warranties and service contracts expire, ensuring long-term sustainability. By integrating income-generation activities into existing facilities e.g., rent payments by 3rd party-operated canteens, the model presents a

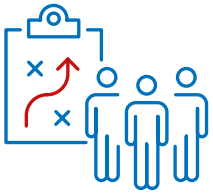
Canteen/Kiosk at Ofua HC III Photo Credit: Sandra Haskamp

creative and practical strategy to enhance the reliability and lifespan of energy systems, particularly in resource-constrained settings.

The experiences and best practices shared across various initiatives in displacement settings highlight the transformative potential of innovative energy access solutions. By integrating adaptive management approaches, such as the hybrid RBF model and direct PAYGO services, these projects have improved accessibility and reliability of energy products and electricity services, driving customer growth and support to local economies.

Challenges and Lessons Learnt

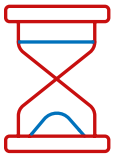
The following recommendations tackle key challenges in implementing sustainable electricity access in displacement settings. Based on experiences with mini-grids, solar product distribution, energy kiosks, and solarized health centres, they offer practical solutions to overcome regulatory barriers, improve efficiency, and foster collaboration. Tailored to the complexities of displacement contexts, these insights focus on community engagement, resource management, and customer-centred strategies to scale energy access. Derived from project documents, surveys, and discussions, they provide actionable guidance for designing and improving future energy interventions.



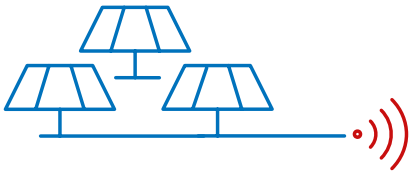
Operational Challenges for some RBF Recipients: Several RBF recipients faced barriers in implementing product sales in refugee settlements, worsened by Covid-19 movement restrictions in Uganda. Ensuring a consistent SHS supply was a key challenge, as commission-based sales agents could only handle limited stock, requiring frequent replenishment. Poor road conditions, lack of affordable warehousing near settlements, and the high costs of establishing local distribution infrastructure further complicated efforts. The absence of energy kiosks with a clear and formalised legal status significantly hindered solar companies from establishing local stocking contracts, as it complicated adherence to standards, risk mitigation measures, and accountability procedures.
PAYGO services through mobile money added complexity, as many customers struggled with weekly payments due to unpredictable cash flow. To avoid mobile money fees, cash payments were accepted via local agents, creating accountability concerns. To address these issues, companies adapted by improving customer engagement, addressing language barriers, and assisting refugees with mobile payments. Some streamlined customer relationship management (CRM) systems and leveraged high transaction volumes to lower mobile money fees, improving service delivery and financial accessibility.

Challenges of Energy Kiosks in Collaborating with Solar Suppliers: In Uganda, solar product suppliers and their associate sales agents have worked with energy kiosks to improve last-mile access to solar lanterns, ICS and SHS. However, challenges with energy kiosks arose as formalizing and scaling these collaborations have proven difficult. Only 15% of eligible sales tied to the RBF scheme were made through energy kiosks. Most solar suppliers depend on commission-based sales agents as their primary sales strategy and face difficulties using energy kiosks as distribution points due to concerns over accountability, stock management, and the feasibility of PAYGO schemes. Further challenges arise from internal issues, such as the energy kiosk's group-based structures that complicate decision-making with external partners.
Despite challenges, informal collaborations have emerged, with energy kiosks serving as points for consumer engagement. Some solar suppliers find local sales agents improve distribution efficiency. However, concerns about kiosk operators' impartiality persist, as there have been observations that they favour prioritizing subsidized sales to individuals they know rather than adhering to fair, transparent processes. This issue arises from the lack of formal processes and controls, which are crucial for ensuring accountability, especially with external funding involved.

High Demand for the Multi-Purpose Energy Hub Results in Customer Dissatisfaction: A core challenge facing the energy hub in Nguenyyiel Camp is its limited capacity due to high demand for phone charging which also serves household lighting needs. The current 3kWp solar PV system serving 260–330 customers per day often reaches its maximum output resulting in frequent power outages, disrupting key services like the cinema and leading to growing customer dissatisfaction (see O&M Section for further information).



Delayed Mini-grid Operationalisation in Uganda: The commissioning of mini-grids in the Palabek Refugee Settlement, Uganda, faced significant delays due to multiple challenges. Initially, the selected developer encountered internal financial difficulties, which prevented the timely commencement of installation activities. Following installation, additional delays arose due to unfinished distribution networks necessary for connecting local users. The responsibility for these networks lay with Uganda's MEMD, further postponing the operationalisation of the mini-grids. These delays partially hindered efforts by other partners such as AVSI working on PUE promotion and highlights the importance of the need for coordinated and synchronous efforts in project implementation.



Grid vs. Mini-grid Encroachment and Connectivity Challenges: Expanding the Kalobeyei mini-grid to a 2.4 MW system near Kakuma faces regulatory issues due to overlapping service areas with Kenya Power and Lighting Corporation (KPLC). The encroachment of national grids into mini-grid areas raises concerns about safeguarding investments and tariff discrepancies. Mini-grid operators have limited-term licenses (up to 21 years) but lack clarity on asset ownership or transfer post-expiration. Community engagement in Turkana County also presents unique challenges. Language barriers complicate outreach, as many refugees in Kalobeyei are from South Sudan and do not speak Kiswahili or English. This hinders effective communication about connectivity options and costs, requiring tailored approaches to ensure inclusion and understanding.

O&M Issues:

Systems / Facilities	O&M Issues
SHS	SHS users in Ugandan displacement settings often have limited English skills, complicating remote troubleshooting efforts by suppliers. Users often perform mechanical repairs themselves, which leads to further complications, especially when systems are still under warranty. Common issues observed include overload of SHS via phone charging which leaves users without evening lighting.
Kiosks	Ethiopia's multi-purpose energy hub faces growing demand, especially for phone charging, straining its 3 kWp solar PV system, particularly in rainy seasons. Under the rental model, O&M responsibility falls to the facility owner, but clarity on maintenance and a robust O&M plan is lacking. Operators struggle to invest in upkeep due to shared infrastructure and lack of ownership, limiting their ability to manage maintenance independently.
Health Centres	Some health centres in Uganda face technical issues with solar PV components like inverters, one of which overheated and caught fire, highlighting safety concerns. Excessive system use, often from staff devices (e.g., kettles) and patient phone charging, can overload inadequately sized systems. All centres lack a comprehensive O&M or funding plan, risking poor maintenance, especially after warranties expire. Multiple solar PV systems, often funded by development partners, add complexity to O&M due to varied brands and configurations, raising costs and complicating troubleshooting. The "canteen" model generates limited revenue, covering small expenses like bulbs and cables but insufficient for major system replacements.

These challenges underline the importance of a multi-layered approach combining financial, educational, technological and infrastructural aspects to drive the successful adoption of sustainable cooking technologies in displacement settings.

Recommendations

SUN-ESDS's experiences across countries show promising opportunities to improve and scale market-based electricity access solutions. However, O&M remains a challenge for public institutions and CBO-operator models without addressing financial, technical, and managerial bottlenecks. Despite this, SUN-ESDS has laid a strong foundation for scaling electricity access, driving local economic development in displacement settings. These early lessons can inform future project implementation and coordination efforts, as outlined in the following recommendations:

Scale-up Implementation of Hybrid RBFs in Displacement Settings: There is considerable potential for Tier 1 SHS sales in Uganda and for solar charging lanterns in Ethiopia. Beyond providing sales incentives, it is crucial to strengthen local distribution infrastructure to address stock replenishment challenges. This can be achieved through partnerships with formal entities, investments in secure shared stocking points, and the development of shared local transportation systems to reduce last-mile delivery costs. Additionally, maintaining after-sales services in Uganda requires addressing language barriers by empowering local communities with SHS maintenance skills and encouraging solar companies to diversify their staffing concepts. This could also help companies in targeted marketing and outreach efforts in local languages, which could be facilitated more strongly through additional upfront financing or direct local marketing support as part of future RBF schemes.

Tailored PAYGO terms, developed in collaboration with mobile money operators, could further enhance affordability by subsidizing, reducing, or eliminating transaction fees for SHS repayment. Establishing a specialized mobile money transaction entity to subsidize costs for critical goods could significantly increase accessibility for underserved communities. Such a mechanism would align with UNHCR's broader goals of enabling affordability and expanding energy access in displacement settings.

Scale-up the "Green House" in Uganda as a Catalyst for Solar Product Adoption: The rising popularity of the "green house" as a trusted hub for phone charging and access to high-quality solar products underscores its potential to drive sustainable energy adoption. By collaborating with established solar suppliers, these kiosks can become platforms for product demonstrations and customer education, fostering greater awareness and adoption of sustainable energy technologies. Integrating the "green house" into cash and digital PAYGO systems can further address challenges solar suppliers face in managing last-mile repayments, making solar products more accessible and repayment processes more efficient for partner solar suppliers.

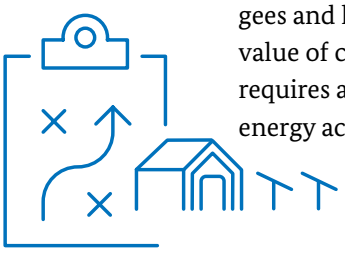
To realise this potential, operators will require enhanced mentoring, capacity-building, and technical training. Additionally, support is needed to transform these kiosks into more formalized, professional entities capable of entering contractual agreements, maintaining business integrity and expanding their services. This strategic development will strengthen their role as catalysts for solar product adoption and sustainable energy solutions in Uganda.

Expand and Replicate Multi-purpose Energy Hubs in Ethiopia: The energy hub in Nguenyyiel Camp, currently serving 260–330 customers per day with a 3kWp solar PV system, is reaching its maximum capacity. This is resulting in frequent power outages that affects services like the cinema, leading to growing customer dissatisfaction. To harness the high demand and sustain interest in these hubs, it is crucial to scale up their capacity to around 5kWp and replicate the model across additional camp locations and camps, expanding access to energy, convenience, and recreational services for more refugees. This expansion can be supported by forging multi-stakeholder partnerships and exploring innovative investment and ownership models to ensure sustainability. Incorporating flexible business models with varied operating hours under a unified structure, alongside clear agreements among shared users, will improve service delivery. Additionally, close monitoring and support for O&M activities will be essential to maintain functionality.

Pursue Policy Clarity and Align Processes to Scale Mini-grid Development: Scaling mini-grids requires significant investment, which is difficult without strong regulatory support - especially in displacement settings where lower incomes affect demand and payment reliability. Innovative models like blended finance help attract investment, but long-term success needs clear policy frameworks and PPPs suited to these contexts. Key measures include asset buyout mechanisms to protect investors, tariff harmonization for affordability, and shared operational models to integrate with the national grid. Flexible payment options and culturally sensitive outreach for refugees are crucial to ensuring stable, inclusive, and scalable energy access for both host and displaced communities.

Consider Pooled O&M Arrangements in Displacement Settings: To address the challenges of maintaining multiple solar PV systems in health centres, a centralized O&M provider, preferably local, could streamline repairs and upkeep across various sites. Pooling costs among humanitarian, development, peace actors, and local authorities would reduce financial burdens, enable bulk procurement of spare parts and services, and support specialized service providers to support critical infrastructure, improve service delivery, and, over time, standardize monitoring tools and reporting mechanisms. The approach could extend beyond health centres to other public services like schools, administrative buildings, and marketplaces, reducing downtime and improving overall efficiency.

SUN-ESDS's market-driven strategies, such as the hybrid RBF model and blended finance for mini-grid developments, have effectively improved electricity access and economic opportunities in displacement settings. Incentives for SHS sales and PAYGO services boost demand, create jobs, and support sustainable development for refugees and host communities. Successes in Uganda, Ethiopia, and Kenya underscore the value of community-tailored solutions and strategic co-financing. Scaling these efforts requires adapting to local economic conditions and strengthening policies to expand energy access, improve livelihoods, and promote inclusive solutions.



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